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# APPENDIX I

## PRODUCTION OF IHPF COMPONENTS HAVING A FLANGE

### BACKGROUND AND SUMMARY OF THE INVENTION

[0001] This invention relates to a method of producing a hollow profile having at least one flange by means of internal high pressure forming.

[0002] Conventional hollow profiles with flanges are generally produced by extrusion. In automobile construction, the flange is required in order to fasten the hollow profile, produced by extrusion for example, to further vehicle body parts.

[0003] German document DE 10130794 A1, for example, discloses an extruded profile which has a flange and is subsequently subjected to internal high pressure forming, the course and the direction of the flange over the length of the structural part not being established in a dimensionally accurate manner until during deformation according to the internal high pressure process.

[0004] However, an extruded hollow profile having a flange generally has the disadvantage that the hollow profile can only be bent and/or widened with difficulty. The reason for this is that the connecting point of the flange on the hollow profile acts like a tension rod against the forming force. In addition, on account of the accumulation of material at this connecting point, the flange cannot expand

sufficiently and therefore the hollow profile cannot be formed in a controlled manner.

[0005] It is known from German document DE 19905365 A1 to produce a hollow profile having a flange by roll forming from a sheet-metal blank. The hollow profile is then subsequently subjected to internal high pressure forming. In this case, the flange is established beforehand in such a way that its position and dimensions are not formed until during the internal high pressure forming. However, such a method is complicated in its implementation inasmuch as that portion of the flange on the initial hollow profile which is to be deformed during the internal high pressure forming has to be accurately established or calculated as a function of the holding-down force for the flange on the one hand and the internal high pressure to be applied on the other hand. In addition, the hollow profile shown in this publication has the disadvantage that the initial hollow profile has sharp edges, which, on account of the pronounced hardening during the profile production process, can remain behind as visible residual edges or undulations on the final finished hollow profile produced by the IHPF process. The bending-back or stretching of such profile edges, hardened to a pronounced extent, cannot be completely taken into account in the IHPF process.

[0006] Starting therefrom, the object of the present invention is to provide a method of producing a hollow profile by means of which a hollow profile having at least one flange can be produced in a simple and controlled manner.

[0007] This object is achieved by a method having the features claimed.

[0008] The method is distinguished by the fact that an initial hollow profile consists of a single sheet, at least one flange being formed in the longitudinal direction of the initial hollow profile likewise by corresponding folding or roll forming of the sheet. The sheet can be produced in particular from a sheet-metal blank and/or a roll-formed sheet unwound from the coil.

[0009] Then, in order to form a closed initial hollow profile, the joint location of the sheet is welded and the closed initial hollow profile is inserted into an internal high pressure forming (IHPF) tool. During the insertion, the at least one flange is positioned in a corresponding cavity in the IHPF tool and is clamped in place with a defined holding-down force during the internal high pressure forming.

[0010] According to the invention, the inner contour of the IHPF tool, on the one hand, and the holding-down force to be applied on the flange during the internal high pressure forming, on the other hand, are selected in such a way that

the position of the flange always remains unchanged relative to the finished hollow profile then formed.

[0011] In this case, it is possible according to the invention to establish the holding-down force in such an order of magnitude that a subsequent flow of material into the finished hollow profile on no account occurs during the internal high pressure forming.

[0012] Under certain circumstances, however, it may also be desired for such a subsequent flow of material from the flange into the finished hollow profile to be allowed, so that a corresponding holding-down force is to be selected.

[0013] According to the invention, the flange can be produced in different ways during the folding or roll forming of the sheet.

[0014] Thus it is possible for the flange to be formed by doubling of the material of the sheet during the folding or roll forming, that is to say the sheet is folded over or roll-formed, with the flange being formed.

[0015] Another possibility is to fold or roll-form the sheet in such a way that the two ends of the sheet form an overlapping joint for forming the flange.

[0016] However, it is also possible for the sheet to be folded or roll-formed at one end, with the flange being formed, and for the other end, during the folding or roll-forming, to be formed in such a way that it abuts against the transition region between the flange and the initial hollow profile.

[0017] In order to form a closed initial hollow profile, the sheet is welded together in the region of its free ends. Since these free ends can lie in the region of the flange or outside this region, welding is carried out there in each case.

[0018] If a subsequent flow of material from the flange is desired during the internal high pressure forming, the weld is at any rate located outside the flange region in the initial hollow profile.

[0019] Hollow profiles produced by the method according to the invention are suitable, for example, for use in body construction as roof frames, side sills, transverse members or longitudinal and transverse members in the body floor assembly, in which case the adjacent body components can then be attached to the flange by conventional joining processes, such as resistance spot welding for example.

[0020] Further advantages and features of the method according to the invention follow from the description below with reference to the attached drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Figure 1 schematically shows an IHPF tool with a flange clamped in place;

[0022] Figures 2a and 2b show an initial hollow profile with different positions of the weld;

[0023] Figure 3 shows a further initial hollow profile with a single flange; and

[0024] Figures 4a and 4b respectively show an initial hollow profile with a weld outside the flange region.

## DETAILED DESCRIPTION OF THE INVENTION

[0025] Shown schematically in Figure 1 is an IHPF tool 1 which consists of a top part 2 and a bottom part 3. Both parts 2 and 3 form a cavity 4, which corresponds to the contour of the final finished hollow profile.

[0026] A sheet-metal blank formed into an initial hollow profile 5 is inserted into this cavity 4. The initial hollow profile 5 has a flange 6, which is clamped in place in a corresponding section 7 of the cavity 4.

[0027] The clamping in place can be effected with such a holding-down force that either no subsequent flow of material can take place from the region of the flange 6 into the finished hollow profile or such a subsequent flow of material is allowed.

[0028] By way of example, Figures 2a and 2b show an initial hollow profile 5 in which a flange 8 is formed by an overlapping joint of the free ends of the sheet. The flange 8 can then be welded either by a weld 9 being provided in the joint region of the flange 8 (Figure 2a) or by a weld 9 being provided in the course of the flange 8 transversely to the latter (Figure 2b).

[0029] Furthermore, by way of example, Figure 3 shows an initial hollow profile 5 in which the flange 10 is formed by a free end of the sheet being appropriately bent over and by the other free end being welded on in the transition region between the flange 10 and the initial hollow profile 5.

[0030] A further possibility consists in forming a flange 11 of the initial hollow profile 5 in such a way that the sheet is folded over and thus overlaps in the region provided for the flange 11. This is shown by way of example in Figure 4a for a single flange 11 and in Figure 4b for two flanges 11. In both cases the weld 9 is located outside the flange in the region of the initial hollow profile 5. Such an initial hollow profile with a weld 9 established outside the flange region is preferably to be

used when a subsequent flow of material from the region of the flange 11 during the internal high pressure forming is to be permitted.